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FUEL INJECTOR

FIELD OF THE INVENTION

The present invention relates to a fuel injector.

BACKGROUND INFORMATION

German Patent Application No. DE 197 12 921 A1 describes a fuel-injection system which includes a cylinder head and at least one fuel injector having piezoelectric actuation. A fuel-supply line through which fuel flows into the individual fuel injector under relatively low pressure (3 to 4 bar) on the side, below the actuator, is provided in the cylinder head. Because of the actuator lifts and the action of a piston pump integrated in the fuel injector in the discharge-side region, the fuel is injected into the combustion chamber under a much higher pressure.

In particular when using this system in internal combustion engines having fuel injectors of a simpler construction and high-pressure injection without integrated pump, a disadvantage is that the fuel lines located outside the cylinder head will have been produced in a very complex manner and may be costly due to their unavoidable flexibility. The required space, the installation effort and the susceptibility to faults, especially with respect to external mechanical influences, is increased considerably.

SUMMARY

A fuel-injection system according to an example embodiment of the present invention may have the advantage that the required space, installation expense and the susceptibility to faults are considerably reduced. Moreover, the fuel-injection system

may be very resistant to mechanical external influences. In addition, the number of detachable and fault-susceptible high-pressure connections may be markedly reduced.

In a preferred exemplary embodiment of the fuel-injection system according to the present invention the fuel connection of the fuel injector is arranged at the level of the valve needle. This allows for a very simple design of the fuel injector. In particular, it is possible to dispense with extensive sealing of the actuator chamber or the actuator and to use smaller dimensions for the fuel injector. This considerably reduces the installation space of the fuel injector in the cylinder head and improves the stability of the cylinder head.

The fuel lines may also be connected via at least the valve receiving openings and/or the fuel connections. In this way an especially simple interconnection of the fuel lines is possible.

In another preferred exemplary embodiment, the fuel connection has an outer first section and an inner second section, which is made up of at least one opening introduced into the side of the fuel injector. This may make it especially easy to adapt the fuel connection to the stability requirements in the region of the fuel connection and to the required flow characteristics that result, for instance, from the position in the fuel system.

The fuel lines may be interconnected via at least two openings in the second section, and/or the first section of the fuel connection extends in the form of an annular groove. Two fuel lines are, thus, able to be interconnected in a reliable and simple manner.

In addition, a fuel-line array formed by at least two fuel lines positioned one behind the other may supply fuel to at least two fuel injectors. The fuel lines are thus able to be positioned in the cylinder head in a simple and hydraulically advantageous manner.

In another preferred exemplary embodiment of the fuel-injection system according to the present invention, the fuel lines of a fuel line system are placed coaxially with respect to each other and/or are formed by a shared borehole. The fuel lines are thus able to be positioned in the cylinder head in an especially simple and hydraulically advantageous manner.

Due to the advantageous hydraulically parallel positioning of at least two fuel line arrays, it is possible to set up the fuel lines in the cylinder head in a simple and hydraulically advantageous manner even if a larger number of fuel line arrays is involved.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the present invention is represented in simplified form in the figures and is explained in greater detail below.

Fig. 1 shows a schematic sectional view of an exemplary embodiment of a fuel-injection system configured according to the present invention.

Fig. 2 shows a specific example embodiment of a cylinder head of a fuel-injection system configured according to the present invention.

DESCRIPTION OF EXAMPLE EMBODIMENTS

Fuel-injection system 1 shown in Figure 1 is generally made up of a fuel injector 5 which is suitable as fuel injector 5 for fuel-injection systems of mixture-compressing internal combustion engines having external ignition for the direct injection of fuel into the combustion chamber of the internal combustion engine, and a cylinder head 10, which is shown only in part and has fuel lines 11 extending therein, which are interconnected inside cylinder head 10.

Fuel injector 5 engages with a cylindrical valve receiving opening 16, which is positioned in cylinder head 10, extends in the direction of the combustion chamber (not shown) and has a tapered design. In this exemplary embodiment, fuel injector 5 projects into the combustion chamber through valve-receiving opening 16 via its discharge-side end.

Fuel injector 5 is generally made up of a circular-cylindrical housing 3, which is sealed by a top 20 on the discharge-remote side, a nozzle body 14, an actuator 2 such as a piezoelectric actuator, and a valve needle 12 on which a valve-closure member 13 is formed on the discharge side.

Cylindrical nozzle body 14 partially engages with the discharge-side end of housing 3. In the exemplary embodiment, the profile of nozzle body 14 outside housing 3 tapers in the direction of the combustion chamber (not shown) via a step 23. Valve needle 12 is positioned coaxially in nozzle body 14 and in an axially moveable manner. It is guided via an annular guide element 32 which tightly surrounds valve needle 12 on the discharge side of a flange 21 and is located on the inner wall of nozzle body 14 in an immoveable manner.

Arranged on the discharge-side end of nozzle body 14 is a valve-seat body 15 integrally formed with nozzle body 14,

valve-seat body 15 having a coaxially disposed discharge orifice 26 on the discharge side. Valve-closure member 13 coöperates with valve-seat surface 24 formed on valve seat member 15 to form a sealing seat. In the rest state, valve-closure member 13 of the outwardly opening fuel injector 5 is drawn into the sealing seat by a restoring spring 17 which is braced on nozzle body 14 and engages with valve needle 12 via a disk element 18 in the form of a perforated disk. The spring force of restoring spring 17 simultaneously retains the discharge-remote end of valve needle 12 in permanent contact with a coupler 4. This permanently clamps actuator 2 between coupler 4 and top 20.

An annular seal 22 between step 23 and the discharge-side end of nozzle body 14 seals nozzle body 14 from cylinder head 10. Nozzle body 14 rests in a hermetically sealing manner on a correspondingly formed shoulder 34 of valve-receiving opening 16 by way of step 23, for instance with the interposition of a seal which is not illustrated.

The discharge-side portion of nozzle body 15 projecting into the combustion chamber (not shown) tapers conically into the combustion chamber up to spray-discharge orifice 26 positioned coaxially in nozzle body 14, valve needle 12 having valve-closure member 13 reaching through spray-discharge orifice 26.

Fuel injector 5 has a center axis 19 with respect to which, in particular, actuator 2, restoring spring 17, hydraulic coupler 4 and valve needle 12 are coaxially arranged in this exemplary embodiment.

An actuator chamber 31 which is located in housing 3 and surrounds actuator 2 is sealed against the entry of fuel by convoluted bellows 30 which radially enclose valve needle 12.

Via its discharge-side end, convoluted bellows 30 is attached to valve needle 12 by way of flange 21; its discharge-remote end has been affixed in the region of the discharge-remote end of nozzle body 14, for instance in an integral manner.

In the exemplary embodiment shown, fuel connection 8 is radially positioned in nozzle body 14, between the discharge-side end of housing 3 and step 23. Fuel connection 8 lies on the same level as fuel lines 11, the two fuel lines 11 discharging into fuel connection 8. In the exemplary embodiment shown, fuel connection 8 is made up of a first section 28 and a second section 29. In the exemplary embodiment, first section 28, lying radially on the outside, has two cylindrical bores, which lie opposite one another and on the same axis as the two fuel lines 11, but first section 28 may also be embodied as a groove encircling nozzle body 14 radially.

Second section 29, which follows first section 28 on the inside, has a smaller flow cross section, and it has two cylindrical openings lying opposite each other and on the same axis as fuel lines 11.

A filter 9, which may be made of a tightly meshed material or a sieve-type laser-drilled material, for example, may be positioned upstream from fuel connection 8. Filter 9 is made of metal, for instance, and has the form of a circumferential ring, in particular in a first section 28 formed as annular groove. Filter 9 keeps harmful particles contained in the fuel away from fuel injector 5. The particles may be washed out of cylinder head 10 via a return line (not shown) connected to fuel lines 11.

Above and below fuel connection 8, circumferential annular sealing elements 27 are inserted in nozzle body 14 between step 23 and housing 3. Sealing elements 27 rest on the inner circumference of valve-receiving opening 16 in a hermetically sealing manner and prevent leakage of the fuel supplied via fuel line 11. In the exemplary embodiment shown, the portion of nozzle body 14 extending above step 23 does not abut the inner circumference of the valve-receiving opening. Instead, between the two sealing elements 27 nozzle body 14 has a smaller diameter than the inner diameter of valve-receiving opening 16 between both sealing elements 27. This makes it possible for the two fuel lines 11 shown to exchange fuel even without first section 28 having an annular groove design and/or only one opening being provided in second section 29 of fuel connection 8.

In response to excitation, actuator 2 expands, and, with the aid of hydraulic coupler 4, presses valve needle 12 in the discharge direction, counter to the spring force of restoring spring 17. Valve-closure member 13 lifts off from valve-seat surface 24, and the fuel supplied via fuel connections 8 and along valve needle 12 is spray-discharged into the combustion chamber (not shown) via spray-discharge orifice 26.

Figure 2 schematically shows a specific example embodiment of a cylinder head 10 of a fuel-injection system 1 according to the present invention. Illustrated cylinder head 10 is part of, for instance, a reciprocating combustion engine having three cylinders set up in series or a V6 cylinder engine having two cylinder heads 10. Cylinder head 10 has three valve-receiving openings 16 which correspond to the valve-receiving openings 16 indicated in Figure 1. Cylinder head 10 has on its side a connection 7 designed as high-pressure

connection, which is connected to a high-pressure pump (not shown) via a filter device (not shown), for instance.

In this way fuel is pressed into the three fuel lines 11, which in the exemplary embodiment are positioned one behind the other and coaxially relative to each other, for instance at 40 to 2000 bar and with the engine of the motor vehicle running. The three fuel lines 11 connected in series form a fuel-line array 33. In other exemplary embodiments a plurality of fuel-line arrays 33 may be positioned in a hydraulically parallel manner, for instance with the aid of a connection line (not shown) which likewise runs in cylinder head 10. Combinations of series and parallel arrangements are possible as well.

The features of the exemplary embodiment of the fuel-injection system and the specific embodiment of cylinder head 10 may be combined in any manner desired.